13. At 118/At 7:8/MDDC-1142
MDDC-1142
MDDC-1142

MDDC - 1142

UNITED STATES ATOMIC ENERGY COMMISSION

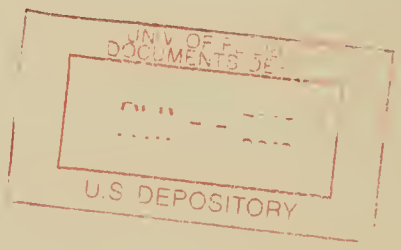
METABOLISM OF FISSION PRODUCTS

Progress Report for Month Ending March 15, 1943

by

Joseph G. Hamilton

Argonne National Laboratory



This document consists of 12 pages.
Date of Manuscript: March 15, 1943
Date Declassified: July 14, 1947

This document is for official use
Its issuance does not constitute authority
for declassification of classified copies
of the same or similar content and title
and by the same author(s).

Technical Information Division, Oak Ridge Directed Operation
Oak Ridge, Tennessee

TABLE OF CONTENTS

	Page
ABSTRACT	1-2
RADIOLANTHANUM (La^{140}) (Complete Report)	1
1) Preparation Without Carrier, Roy Overstreet and Louis Jacobson	1
2) Tracer Studies, Kenneth Scott and Harvey Fisher	1
RADIOCERIUM (Ce^{140}) (Progress Report)	1
1) Preparation Without Carrier, Roy Overstreet and Louis Jacobson	1
2) Tracer Studies, Kenneth Scott and Harvey Fisher	2
UNSEPARATED FISSION PRODUCTS (Progress Report)	2
Preparation of a New Sample Without Carrier, Roy Overstreet and Louis Jacobson	2
RADIOSTRONTIUM (Sr^{85}) (Progress Report)	2
Tracer Studies, I. L. Chaikoff, M. C. Fishler, and C. Entenman	2
A PRELIMINARY STUDY OF THE REMOVAL OF RADIOSTRONTIUM (Sr^{85}) FROM THE BODY, (Progress Report), D. M. Greenberg and Nathan Kaplan	2
RADIOLANTHANUM (La^{140}) (Complete Report)	2
1) Preparation Without Carrier	2
2) Tracer Studies	3
Method of Study	3
Results	5
Discussion	7
A PRELIMINARY STUDY OF THE REMOVAL OF RADIOSTRONTIUM (Sr^{85}) FROM THE BODY	9
Experimental	9
Results	9
PLAN OF FUTURE EXPERIMENTS	12

METABOLISM OF FISSION PRODUCTS

By Joseph G. Hamilton

ABSTRACT

RADIOLANTHANUM (La^{140})

1) Preparation of Radiolanthanum Without Carrier

A satisfactory method for the preparation of La^{140} has been successfully developed. The twelve-day Ba^{140} has been separated from fission products with the use of inert Ba as a carrier. Following the preparation and purification of the Ba^{140}, the radiolanthanum was separated from the former using ferric hydroxide as carrier. The iron was subsequently removed by extraction with isopropyl ether. Decay curves have been measured on La^{140} samples thus separated and the half-life found to be 40.9 hours. No detectable long-lived tail was observed in samples followed over as long an interval as seven half-lives. This indicates that there was present less than 1% of any long-life impurities such as radiobarium or radioactive rare earths. The half-value thickness for the beta rays using Al absorbers was found to be 86 milligrams per square centimeter.

2) Tracer Studies

The distribution of La^{140} following intraperitoneal and intramuscular injection was followed for a period of eight days. A significant proportion of the injected material remained unabsorbed by both routes of administration. The liver and skeleton were found to show the highest accumulation of this element. The uptake per gram of tissue in the liver was considerably higher than in the case of Y^{86}. The uptake by the bone per gram of weight was significantly less in the case of La^{140}. However, the La^{140} was accumulated in the bone and was firmly fixed in this organ. No significant absorption took place by way of the digestive tract. When La^{140} was introduced directly into the lungs, it was found that a large proportion was firmly fixed in this structure.

RADIOCERIUM (Ce^{140})

1) Preparation Without Carrier

Radiocerium has been prepared from a uranium fission mixture without the use of Ce carrier. Thorium was used as a carrier, and the thorium and cerium finally separated from one another by iodate precipitation. The identity of the purified radiocerium without carrier was demonstrated by the following procedure:

a) Chemical identification with the use of inert Ce as a carrier upon an aliquot fraction of the final purified solution.

b) Confirmation of the presence of short-lived praseodymium daughter which was described by Spedding in report CC-418.

c) Beta-ray absorption curves were found to be comparable to those published in various reports of the chemistry group.

2) Tracer Studies

A large group of animals have been injected with $Ce^{>140}$ by intraperitoneal and intramuscular injection without carrier. A sufficient number have been injected so that they may be sacrificed in groups of 3 extending from the 1-day period to the 64-day period. In addition, some animals have received $Ce^{>140}$ by stomach tube. Preliminary results, which include the 1-, 4-, 8-, and 16-day period, reveal that $Ce^{>140}$ is handled in a manner very similar to that observed with La^{140}. No significant absorption occurs by way of the digestive tract. Considerable retention by the lungs was noted when the radiocerium was administered directly into this organ. A full report will follow.

UNSEPARATED FISSION PRODUCTS

Preparation of a New Sample Without Carrier

Eighteen pounds of uranyl nitrate have received 10,000 microampere hours of beryllium neutrons. The bombarded material was then extracted repeatedly with ether to remove the uranyl nitrate, and the fission products were separated without the addition of carrier. This separated mixture now contains less than 5 milligrams of uranium in a total of 8 millicures of activity. An assay of the different fission products is now being completed and the material should be ready for use April 1 for tracer studies.

RADIOSTRONTIUM (Sr^{85})

Tracer Studies

A continuation of this work with more complete data indicates that the retention of Sr^{85} by the skeleton was essentially as has been described in a previous report, CH498. The uptake of this material in the bones of the animals, which received it by mouth, was found to rise by almost a factor of 2 between the 4th and 16th days. Otherwise, there were no significant differences to be observed between the present more complete information and that which was given previously. The rate of excretion of Sr^{85} has now been followed for a period of 30 days, and after the 15th day its rate of excretion is apparently less than the rate of decay of that which is retained in the body. A complete report on the Sr^{85} studies up to 64 days will be presented in the next six weeks as a complete report.

A PRELIMINARY STUDY OF THE REMOVAL OF RADIOSTRONTIUM (Sr^{85}) FROM THE BODY

Preliminary experiments on removal of Sr^{85} from rats have indicated that sodium citrate, parathyroid hormone, ammonium chloride, and strontium chloride apparently slightly enhance the removal of Sr^{85}. Massive doses of irradiated ergosterol have no such effect. This study must be repeated upon a much larger group of animals at varying periods after Sr^{85} administration before any quantitative apprisals as to the relative effect of these different agents may be made.

* * * * *

RADIOLANTHANUM (La^{140})

1) PREPARATION WITHOUT CARRIER

Uranium metal on an iron target was subjected to a deuteron bombardment of 10,070 microampere hours at 16 Mev. The period of bombardment was from December 8 to December 29, 1942.

On January 23, 1943, all exposed parts of the target, except the uranium, were covered with paraffin, and the uranium was treated repeatedly with concentrated HNO_3. Over 90% of the activity was thus removed from the target. A large excess of concentrated HCl was added and the solution evaporated to a small volume. Iron was removed by extraction with isopropyl ether and the aqueous phase evaporated to a value of 10 cc.

Fifty mg of Ba were added, and the mixture was saturated with HCl gas and the resulting $BaCl_2$ precipitate removed by centrifugation. Twenty-five mg more of Ba were added to the supernatant liquid and $BaCl_2$ again separated out. The Ba precipitates were combined, dissolved in a little water, and reprecipitated 4 times with HCl.

The final $BaCl_2$ precipitate was dissolved in water. Ten mg of $FeCl_3$ were added. The solution was made alkaline with NH_4OH and heated to boiling. The $Fe(OH)_3$ precipitate was removed by centrifugation and discarded. This process was repeated once more and the final $BaCl_2$ solution acidified.

The purified $BaCl_2$ solution was set aside for 7 days to allow for the growth of the lanthanum daughter. Lanthanum was then separated out as follows: Ten mg of $FeCl_3$ were added and the liquid diluted to about 40 cc. The solution, made basic with NH_4OH, was heated to boiling and the $Fe(OH)_3$ separated out. After acidifying, the supernatant liquid was set aside for future "milkings". The $Fe(OH)_3$ precipitate (containing the La) was dissolved in 40 cc of 0.5N HCl and reprecipitated twice with NH_4OH, adding 50 mg Ba as hold-back carrier each time. Following this, the iron was reprecipitated twice without the addition of barium hold-back carrier and finally washed with 40 cc water.

The washed precipitate was dissolved in a small volume of 9N HCl, the iron extracted with isopropyl ether, and the aqueous phase evaporated just to dryness. The residue was taken up in a few drops of concentrated HCl, and diluted with water. Finally, the solution was made isotomic in NaCl, the pH adjusted to 2.7, and the volume made up to 11.0 cc. Suitable aliquots were taken for absorption and decay curves.

For the Al absorption curve, the sample was mounted on cellophane. The decay curve, extending through seven half-lives, showed no evidence of contamination. The half-life, as determined on this sample, was 40.9 hours (see Figure 1). The half-value thickness for the beta rays, as measured on a Lauritsen Electroscope, was found to be 86 mg Al cm^{-2}. This value is similar to the one reported by Goldschmidt and Perlman, CC295.

2) TRACER STUDIES

Method of Study

Three groups of rats, each group comprising 3 animals, received approximately 5 microcuries of the purified radiolanthanum as a $LaCl_3$ solution at pH 2.7 by intraperitoneal injection. Three similar groups of animals received this material by intramuscular injection. The intraperitoneal and intramuscular groups were sacrificed at the following intervals after injection: 1 day, 4 days, 8 days. The excreta were collected from all of the animals as was done in the radioyttrium studies. The tissues were secured from the animals at the time of sacrifice and ashed at 500 degrees centigrade in porcelain dishes. The ash from each sample was weighed and transferred to a small porcelain dish 4 centimeters in diameter. One cc of water was added and the mixture subsequently evaporated in a hot air oven in order to evenly distribute material in the dish. In this manner it was possible to determine with reasonable accuracy the number of milligrams per square centimeter of the ash present. Self-absorption curves, using sodium chloride, were made on aliquot samples of the La^{140} so that proper correction for the self-absorption in each sample could be made. The weaker samples were measured by a counter tube which had a mica window of 11 milligrams per square centimeter. The stronger samples were measured with a Lauritsen Electroscope. The distribution of the radiolanthanum in the tissues of the animals which had received this material by intraperitoneal and intramuscular injection is given in Tables 1, 2, and 3. The excretion data appears in Table 4.

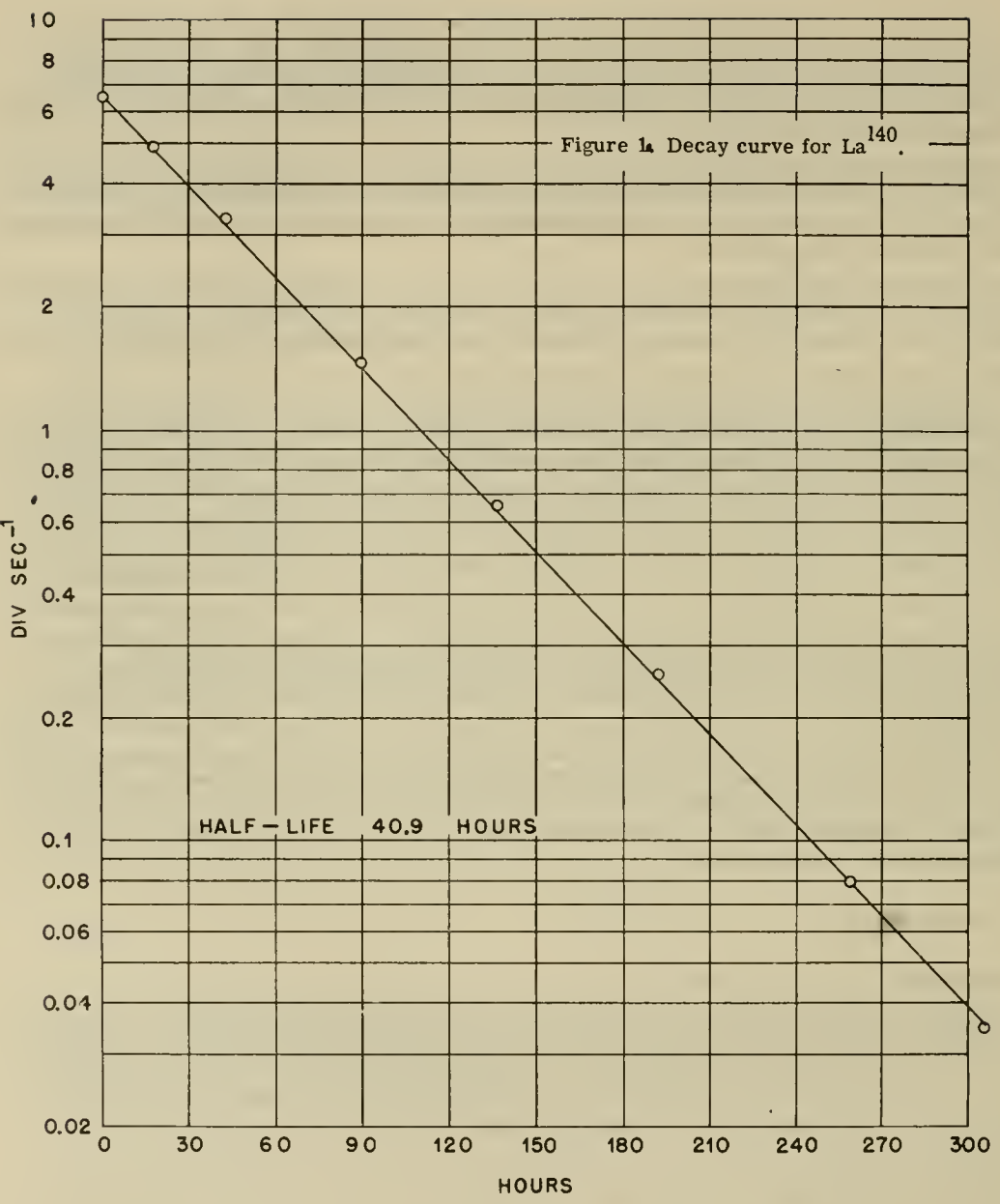


Figure 1. Decay curve for La^{140}.

Each of another group of 3 animals received approximately 5 microcuries of La^{140} solution by stomach tube. Four days later they were sacrificed and their tissues assayed in the manner noted. An additional group of 5 animals were given a solution containing La^{140} directly into the lungs. The exact quantity entering the lungs could not be determined since a considerable proportion of the solution thus administered was coughed up and swallowed. Two of the animals were sacrificed at 2 days, and the remaining 3 at the end of 4 days. The excreta were not collected from these 5 animals. The data concerning the pulmonary experiment are noted in Table 5.

Table 1. Distribution of La^{140} one day following intraperitoneal and intramuscular injection.

	One-day I.P. injection		One-day I.M. injection	
	(% per organ)	(% per gram)	(% per organ)	(% per gram)
Heart	.05	.057	.06	.070
Liver	51.44	5.39	23.00	2.18
Kidney	1.48	.75	.60	.323
Spleen	.76	.77	.06	.096
Muscle[1]	1.16	.011	.66	.006
Skin[2]	2.72	.065	.74	.020
Stomach	.60	.315	.05	.013
Sm. intestine	2.02	.319	.10	.016
Lg. intestine	.22	.247	.02	.025
Bone[3]	16.47	.821	8.53	.300
Lungs	.15	.094	.07	.037
Brain	.007	.003	.009	.006
Blood[4]	.60	.030	.68	.033
Lymph glands		.061		.038
Adrenals	.05	.493		.064
Mesenteric fat		.107		.006
Tail fat		.050		.028
Ovaries			.003	.023
Testes	.43	.087		
Feces		.282		.012
Total urinary excretion	1.19		.039	
Total fecal excretion	6.70		.530	
Balance (carcass[5])	12.74		66.00	
Total recovery	94.50		99.32	

[1] Muscle was calculated on basis of 45% of total body weight.
[2] Skin was calculated on basis of 42 grams.
[3] Measured value for entire skeleton.
[4] Blood was calculated on basis of total body weight.
[5] Measured value of entire carcass less tissue samples and skeleton. This value, less values for muscle and skin, probably is largely made up up of unabsorbed La^{140}.

Results

It is apparent that a very large proportion of the uptake of La^{140} by both intraperitoneal and intramuscular administration occurs in the liver and skeleton. It will also be noted that a considerable proportion of the administered material was present in the carcass. It appears in all likelihood that this is due to lanthanum which escaped absorption. It will also be seen that the carcass values were consistently higher in the intramuscular groups than in those that received lanthanum by intraperitoneal injection. It is also noteworthy that the content of the La^{140} in the abdominal organs is significantly higher in the animals which received this material by intraperitoneal injection. This difference must be due, at least in part, to the fact that part of the solution remained unabsorbed on the surfaces of the intra-abdominal structures. The highest concentrations on a per gram basis are in the liver and bone.

The uptake of La^{140} in the animals which received this material by stomach tube and were sacrificed 4 days later, revealed that approximately .3% was actually absorbed by the body. The small amount which was taken up was found to be in the liver. All of the other tissues and the carcass contained less than .005% per gram of the administered dose. This indicates that the absorption of lanthanum from the digestive tract is insignificant.

The findings noted from the two groups of animals which received the La^{140} solution directly into the lungs, indicated that this substance is apparently very tenaciously held by the pulmonary tissue. (See Table 5). The distribution of the La^{140} in the rest of the tissue is essentially similar to the results noted in the intraperitoneal and intramuscular groups. Unfortunately it is not possible

Table 2. Distribution of La^{140} at four days following intraperitoneal and intramuscular injection.

	Four-day I.P. injection		Four-day I.M. injection	
	(% per organ)	(% per gram)	(% per organ)	(% per gram)
Heart	.03	.038	.03	.035
Liver	39.07	3.34	28.07	2.50
Kidney	.79	.330	.928	.459
Spleen	.39	.342	.072	.062
Muscle[1]	2.34	.019	1.28	.011
Skin[2]	1.38	.031	2.16	.051
Stomach	1.24	.359	.11	.032
Sm. intestine	.92	.070	.46	.047
Lg. intestine	.06	.087	.017	.031
Bone[3]	19.08	.804	24.56	.853
Lungs	.07	.043	.08	.049
Brain	.002	.002	.003	.003
Blood[4]	.042	.002	.067	.003
Lymph glands		.058		
Adrenals		.325	.003	.043
Mesenteric fat		.034		.008
Tail fat		0.13		.013
Ovaries				
Testes	.50	.103	.05	.007
Feces		.535		.290
Total urinary excretion	.407		.278	
Total fecal excretion	7.63		5.20	
Balance (carcass)[5]	18.67		26.77	
Total recovery	88.91		87.89	

[1] Muscle was calculated on basis of 45% of total body weight.

[2] Skin was calculated on basis of 42 grams.

[3] Measured value for entire skeleton.

[4] Blood was calculated on basis of total body weight.

[5] Measured value of entire carcass less tissue samples and skeleton. This value, less values for muscle and skin, probably is largely made up of unabsorbed La^{140} .

Table 3. Distribution of La^{140} at eight days following intraperitoneal and intramuscular injection.

	Eight-day I.P. injection		Eight-day I.M. injection	
	(% per organ)	(% per gram)	(% per organ)	(% per gram)
Heart	.03	.027	.07	.09
Liver	29.77	3.16	19.20	1.87
Kidney	.473	.245	.86	.400
Spleen	.364	.696	.091	.111
Muscle[1]	1.09	.010	1.94	.017
Skin[2]	5.44	.127	3.43	.083
Stomach	.49	.136	.10	.039
Sm. intestine	.88	.098	.367	.036
Lg. intestine	.13	.152	.04	.020
Bone[3]	15.74	.634	25.26	1.127
Lungs	.33	.199	.088	.036
Brain	.023	.021	.031	.018
Blood[4]			.177	.009
Lymph glands		.11		.14
Adrenals	.031	.23	.014	.21
Mesenteric fat				.072
Tail fat				.054
Ovaries	.021	.290		
Testes			.067	.020
Feces		.026		.284
Total urinary excretion	6.00		1.73	
Total fecal excretion	26.14		17.62	
Balance (carcass)[5]	13.30		25.26	
Total recovery	93.13		104.07	

[1] Muscle was calculated on basis of 45% of total body weight.

[2] Skin was calculated on basis of 42 grams.

[3] Measured value for entire skeleton.

[4] Blood was calculated on basis of total body weight.

[5] Measured value of entire carcass less tissue samples and skeleton. This value, less values for muscle and skin, probably is largely made up of unabsorbed La^{140}.

to determine the actual amount of La^{140} injected into the lungs since the largest portion of the solution is promptly coughed out after administration. The values given in Table 5 were secured by removing the digestive tract, then assaying the other tissues in the usual manner. The figures given simply represent the distribution of the measurable activities in the different organs. It will be recalled from an earlier report, CH948, that radioyttrium when introduced into the lungs behaved in a similar manner.

Discussion

It is of interest to note that the distribution of La^{140} following intraperitoneal injection is similar to the results encountered in radioyttrium. It appears that the lanthanum, when fixed in the bones, was held there quite firmly although the total uptake was less than was found with Y^{86}. The absence

Table 4.

Days	No. of determinations	Intraperitoneal injection		Intramuscular injection	
		Urine	Feces	Urine	Feces
1	3	1.06	3.93	.36	.42
2	2	.10	.88	.14	.78
3	2	.16	2.95	.053	2.11
4	2	.16	2.95	.13	2.23
5	1	.19	.67	.077	1.91
6	1	.05	3.37	.077	1.91
7	1	.04	4.60	.087	4.51
8	1	.07	5.45	.099	3.54
Total		1.83	24.80	1.023	17.41

Table 5. Distribution of La^{140} following intrapulmonary administration of a solution of $LaCl_3$.

Tissues	Two days (2 animals)		Four days (3 animals)	
	(% uptake per gram)	(% uptake per organ)	(% uptake per gram)	(% uptake per organ)
Liver	.7	9.1	1.0	12.3
Kidneys	-	-	.4	1.2
Spleen	-	-	.2	.2
Bone	1.5	27.5	.3	10.7
Lungs	25.5	36.7	32.8	64.9
Balance	~.1	~ 26.7	.05	9.7

All other tissues had insufficient La^{140} to be measured, with the exception of the digestive tract in the two-day group where the content of unabsorbed La^{140} was .6% per gram. The content of La^{140} in the other tissues was less than .1% per gram. The distribution given expresses the relative content of measurable La^{140} in the tissues indicated.

of any significant absorption of La^{140} from the digestive tract is quite similar to the findings noted in Y^{86}. The retention of La^{140} in the lungs appears, if anything, to be greater than was noted for Y^{86}. The excretory pattern for La^{140} is likewise similar to that observed with Y^{86}, except that the fecal excretion of the former appears to be maintained at a higher rate with the passage of time. Marked irregularities in the rates of excretion were noted in the different groups receiving La^{140} by intraperitoneal and intramuscular injection.

The general picture of La^{140} is in many respects, therefore, quite similar to observations noted with Y^{86}.

A PRELIMINARY STUDY OF THE REMOVAL OF RADIOSTRONTIUM (Sr^{85}) FROM THE BODY

The first experimental series reported here represents a preliminary experiment. The results obtained are chiefly of value as a guide for the conduct of future experiments and are in themselves inconclusive. In this report there will first be discussed the method of conducting and the results of the present test. This will be followed by an outline of the plan for future experiments.

EXPERIMENTAL

The animals tested were of the same weight and age. After the 21-day preliminary period following administration of Sr^{85}, they were placed in individual metabolism cages each fitted with a device for separating urine and feces. Collections of feces and urine were made daily. The excreta were ashed and the counting was carried out on the whole or aliquots of the ash. At the end of the experimental period, the animals were sacrificed. One femur was removed from each animal to determine the Sr^{85} content of the bones, and the rest of the carcass was ashed to determine the residual Sr^{85} remaining in the body of each animal.

The material to be counted was introduced into metal ointment tins and the radiations were counted with a bell-shaped mica window counter tube. Corrections for self-absorption were applied from standard curves run for this purpose.

The animals were placed on a fairly low calcium diet and given the treatment shown in the heading[5] of Tables 6 and 7. The NH_4Cl, $SrCl_3$, and sodium citrate solutions were put into the drinking water bottles. About 10 cc of each of the fluids were consumed per rat per day. Equivalent doses in an adult man would represent 1.5 million units of vitamin D, 12,000 units of parathyroid hormone, 3 g NH_4Cl, 30 g $SrCl_2$, and 4.8 g of sodium citrate, respectively, per day.

RESULTS

With the exception of the animal given parathyroid extract injections, all the animals survived and appeared in good condition at the end of the experiment.

The following tentative conclusions have been drawn from this first experimental series.

1) Because of the biological variations among animals, a fairly large series of experiments will have to be carried out to obtain results that are statistically significant.

2) The data shown lead to the tentative conclusion that administration of ammonium chloride, strontium chloride, sodium chloride, sodium citrate, and parathyroid extract lead to an increase in the rate of excretion of radiostrontium from the body. frradiated ergosterol does not. The increase in excretion is not large. These results are similar to the findings recorded in the literature on the effects of the treatment of radium poisoning with irradiated ergosterol, ammonium chloride, and parathyroid extract.

3) With the exception of sodium citrate, all the effective treatments caused increase in the Sr^{85} contents of both urine and feces. Sodium citrate, it is noteworthy, caused some decrease in the excretion by way of the urine, and an increase in fecal excretion. This may be a point of some significance in minimizing the contact of the kidneys with the toxic radiations.

Table 6. Elimination of radiostrontium in urine and feces by various regimes expressed as per cent of administered dose.

	Control		Therapeutic regimes: 5000 units ergosterol daily		Therapeutic regimes: 1.0% NH_4Cl	
	Feces	Urine	Feces	Urine	Feces	Urine
Excretion prior to start of experiment						
Total (21 days)	44.5		42.8		39.7	
Excretion prior to start of experimental regimes						
Days						
1	0.093	0.036	0.131	0.018	0.041	0.045
2	0.074	0.062	0.124	0.021	0.068	0.029
Excretion during experimental regimes						
Days						
1	0.082	0.021	0.158	0.062	0.190	0.046
2	0.063	0.030	0.112	0.078	0.162	0.028
3	0.173	0.017	0.088	0.050	0.166	0.045
4	0.158	0.034	0.120	0.054	0.184	0.048
5	0.139	0.030	0.077	0.019	0.186	0.038
6	0.100	0.019	0.065	0.040	0.170	0.027
7	0.106	0.021	0.070	0.060	0.178	0.070
8	0.098	0.027	0.078	0.046	0.136	0.043
9	0.102	0.033	0.077	0.045	0.178	0.032
10	0.077	0.038	0.044	0.041	0.181	0.025
11	0.107	0.013	0.108	0.038	0.204	0.022
12	0.110	0.023	0.049	0.033	0.175	0.017
13	0.111	0.016	0.118	0.031	0.164	0.010
14	0.095	0.020	0.107	0.023	0.191	0.018
Total	1.521	0.342	1.271	0.620	2.465	0.469
Sum of feces and urine	1.86		1.89		2.93	
Carcass	45.9		46.4		51.0	
Bone (femur)	1.6		1.4		2.4	
Recovery (per gram)	93.7		86.5		86.0	

Table 7. Elimination of radiostrontium in urine and feces by various regimes expressed as per cent of administered dose.

	Therapeutic regimes					
	1.0% $SrCl_2$		1.6% Sodium citrate		0.2 cc para-thyroid extract twice daily	
	Feces	Urine	Feces	Urine	Feces	Urine
Excretion before start of experiment						
Total (21 days)	40.6		36.3		29.0	
Excretion prior to start of experimental regimes						
Days						
1	0.034	0.016	0.082	0.048	0.150	0.031
2	0.039	0.025	0.076	0.053	0.116	0.056
Excretion during experimental regimes						
Days						
1	0.216	0.067	0.197	0.010	0.150	0.031
2	0.234	0.100	0.316	0.003	0.153	0.072
3	0.191	0.063	0.214	0.010	0.146	0.080
4	0.172	0.069	0.179	0.015	0.190	0.037
5	0.163	0.081	0.241	0.026	0.148	0.052
6	0.168	0.071	0.185	0.021	0.146	0.033
7	0.150	0.075	0.214	0.016	0.141	0.048
8	0.190	0.053	0.180	0.014	0.211	0.067
9	0.183	0.069	0.201	0.029	0.173	0.052
10	0.154	0.040	0.236	0.019	Animal	
11	0.145	0.061	0.238	0.012	Died	
12	0.216	0.058	0.180	0.014		
13	0.233	0.045	0.195	0.012		
14	0.121	0.025	0.183	0.021		
Total	2.530	0.877	2.959	0.221	1.458	0.442
Sum of feces and urine	3.41		3.18			
Carcass	52.2		56.6		67.4	
Bone (femur)	2.2		2.5		2.9	
Recovery (per gram)	98.4		98.6		91.2	

PLAN OF FUTURE EXPERIMENTS

1) The variability among the experimental animals makes it imperative to run groups of animals for each of the different treatments. The collecting of daily samples involves too much work to allow this. Consequently, it is proposed to carry out the new experiments on weekly samples. Collections will be made at daily intervals, but these will be pooled for the analyses. By this measure it will probably be possible to carry 4 or 5 times as many animals.

2) The current conception of bone metabolism is that material in the trabeculae is removed fairly readily; material in the shaft is difficult to eliminate. The elements that get into the bone first are taken up by the trabeculae and, with the passage of time, are transferred to the shaft. Measures taken early after contamination are apt to be more successful than late measures. The rate of life activity of the rat is about 20-fold as rapid as that of man. This includes life span, growth, etc. Because of this, experiments will have to be undertaken to test the effects of the experimental regimes at different time intervals after the introduction of the radioactive material. As a start, there will be taken the period of 1 week. This is equivalent to about 4 or 5 months in man.

3) The elements that accumulate in bone follow the stream of calcium and phosphorus metabolism. We propose to make more use of this by determining the calcium and phosphorus exchange, as well as the Sr^{85} exchange, in the experiments to be carried out in the future.

UNIVERSITY OF FLORIDA
3 1262 08907 9486